Choice Based Credit System (CBCS) Syllabus for M.A./M.Sc. Statistics

3rd - Semester for Batch 2022 wef 2022 and onwards

BOSPG held on 23/05/2022

General Instructions for the Candidates

1 The **two** years (**4 semesters**) PG Programmes is of **96** credit weightage i.e. **24** credits/semester (**24×4 = 96**).

2 Out of **24** credits in a semester a candidate has to obtain **14** credits compulsorily from the **Core Courses**, while the remaining **10** credits can be obtained from the **Electives (DCE, GE & OE)** in the following manner:

- A candidate can obtain a maximum of **8** credits within his /her own Department out of specialization offered by the Department as **Discipline Centric Electives (DCE)**.
- credits shall be obtained by the candidate from the **Electives (GE, OE)** offered by the Department other than his/her own. The candidate shall be free to obtain these **2** credits from the **General** or **Open Elective or a Combination of both.**

SEMESTER – III			
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**
Core (CR)	ST22301CR	Statistical Inference – I	**04**
	ST22302CR	Multivariate Analysis	**04**
	ST22303CR	Survey Project	**04**
	ST22304CR	Order Statistics	**02**
Discipline Centric Elective (DCE)	ST22305DCE	Demography	**04**
	ST22306DCE	Operations Research – II	**02**
	ST22307DCE	Bio – Statistics	**02**
	ST22308DCE	Practical based on ST22301CR & ST22302CR	**02**
	ST22309DCE	Data Analysis using SPSS	**02**
Generic Elective (GE)	ST22310GE	Data Analysis using Statistical Software	**02**
	ST22311GE	Discrete Probability Distributions	**02**
Open Elective (OE)	ST22312OE	Statistical Quality Control	**02**

STATISTICAL INFERENCE – I

COURSE NO: ST22301CR **No. of Credits-4**

Course objectives: To introduce the concepts of statistical inference.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the concepts of statistical inference.
- Apply the statistical inference tools in real data analysis including sample surveys, design of experiments, and econometrics.

UNIT-I

Statistical Inference: Problems of estimation and Point Estimation, the general statistical decision problem, Example (Point estimation, Interval estimation etc.). Criteria of unbiasedness, consistency and efficiency. Chapman Robin's Inequality, Cramer-Rao Inequality. Minimum variance unbiased (MVU) estimation, UMVU Estimation, Asymptotic relative efficiency, Invariance of consistent estimator under continuous transformation.

UNIT-II

Sufficient and Complete Statistics: Sufficiency, Minimal sufficient statistic, Factorization theorem, Fisher–Neyman criterion. Characterization of distributions. Admitting Sufficient Statistics. Exponential families and Pitman families, Invariance property of sufficiency under one-to-one transformation of sample space. Fisher information for one and several parameter models. Rao-Blackwell theorem. Completeness and Lehman –Scheffle theorem.

UNIT-III

Methods of estimation: Moments Method, Method of maximum likelihood (MLE). Optimum properties of MLE. Maximum Consistent Asymptotic Normal estimators (CAN) obtained by MLE method in one parameter exponential family. Other methods of estimation: Minimum Chi –square, modified minimum Chi –square and least square estimate.

UNIT-IV

Interval Estimation: Determination of confidence interval based on small sample. Determination of confidence interval based on large samples. Relation between confidence estimation and hypothesis testing. Bayesian Interval estimation.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Kale, B.K. (1999): A first course on Parametric Inference, Narosa Publishing House.
- Rohatgi, V. (1988): An Introduction to Probability and Mathematical Statistics. Wiley Eastern Ltd. New Delhi (Student Edition)
- Lehman, E.L. (1986): Theory of Point Estimation (Student Edition)
- Lehman, E.L. (1986): Testing Statistical Hypothesis (Student Edition)
- Rao, C.R. (1973): Linear Statistical Inference
- Dudewicz, E.J. and Mishap, S.N. (1988): Modern Mathematical Statistics. Wiley Series in Prob. Math. Stat., John Wiley and Sons, New York (International Student Edition)
- Ferguson, T.S. (1967): Mathematical Statistics, Academic.
- Zacks,S (1971).Theory of Statistical Inference, John Wiley and Sons, New York.

MULTIVARIATE ANALYSIS

COURSE NO: ST22302CR **No. of Credits -4**

Course objectives: To introduce the elementary and advanced concepts of multivariate analysis tools.

Course outcomes: On successful completion of this course, the students will be able to

- Describe the multivariate analysis tools in relation to univariate tools
- Apply multivariate statistical methods in various applications.

UNIT-I

Multivariate Normal Distribution Theory: Marginal and conditional distribution, Joint distribution, Linear function of correlated normal variate. Characteristics function of multivariate normal distribution, Maximum likelihood estimation of the mean vector and co-variance matrix and their independence. Distribution of sample mean vector. Large sample behavior of mean vector and co-variance matrix. Distribution of non-central chi-square.

UNIT-II

Quadratic form and its distribution. Multiple and partial correlation co-efficient and their sampling distribution. Simple regression model, regression co-efficient and distribution of sample regression co-efficient. Test of linear hypothesis about regression co-efficients and interval estimation.

Canonical Correlation and Canonical variables: Definition, uses, estimation and statistical inference. Distribution of characteristic roots and vectors: The distribution of canonical Correlation.

UNIT-III

Distribution of sample co-variance matrix and the sample generalized variance; Wishart matrix and its distribution. Some important properties of the Wishart distribution. Characteristic function of Wishart distribution.

Generalized T^2 statistics: The general T^2statistics, Derivation of the generalized T^2 statistics and its distribution. Some important properties of T^2 statistics and its uses. Two-sample problem with unequal co-variance matrices. Likelihood criterion for testing independence of set of variate and it moments. Walk's lambda criterion and its distribution. Mahalanobis D^2 statistics and its distribution.

UNIT-IV

Classification and discrimination: Classification and discrimination procedure for discrimination between two multivariate normal populations. Sample discriminant function, tests associated with discriminate function, standards of good classification, probability of misclassification and their estimation, classification into two and more than two multivariate normal population

Principal Component: Definition of principal components, uses, estimation and computation, Statistical inference on principal components.

Factor Analysis: Definition of factor analysis and uses, linear factor models, estimation of factor loading, Factor rotation, estimation of factor scores.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Anderson, T.W (1983): An Introduction to Multivariate Statistical analysis, 2nd ed., John Wiley Johnson,
- R.A. and Wichen, D.W. (1992): Applied Multivariate Statistical Analysis,2nd ed. Prentice Hall.
- Giri, N.C. (1977): Multivariate Statistical Inference, Academic press.
- Kshirsagar, A. M (1972): Multivariate Analysis, Marcel Decker.
- Morrison, D. F. (1976): Multivariate Statistical Methods, 2nd Ed, and Mc Graw Hill.
- Sharma, S. (1996): Applied multivariate technique, Wiley
- Muirhead, R. J. (1982): Aspects of multivariate statistical theory,
- John Wiley. Seber, G.A.F. (1984): Multivariate observations, Wiley.
- Srivastava, M.S. and Khatri, C.G. (1979): An introduction to multivariate statistics. North Holland. Carter and Srivastava: Multivariate Analysis, North Holland.

COURSE NO: ST22303CR No. of Credits-4

SURVEY PROJECT

Using Statistical Software

ORDER STATISTICS

COURSE NO.: ST22304CR **No. of credits -2**

Course objectives: To introduce the basis order statistics.

Course outcomes: On successful completion of this course, the students will be able to

- Demonstrate the understanding of order statistics.
- Understand the marginal and joint distribution functions.

UNIT-I

Single Order Statistics: Cumulative distribution function, probability density function, structural properties and applications. Distribution of extremes. Distribution of median and range and their related examples. The expected value of a random variable between two consecutive order statistics is 1/(n+1).

UNIT-II

Joint order statistics: Joint probability density function of two order statistic, Marginal and conditional distribution of order statistics, extreme value laws and their properties. Correlation between extremes and related examples. Distribution of Range and other systematic statistics

RECOMMENDED TEXT BOOKS & REFERENCES:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- H.A. David, H.N. Nagaraja (2004): Order Statistics, Willy, Third Edition.
- B.C. Arnold, N. Balakrishnan, H. N. Nagaraja (2008): A First Course in Order Statistics, Society for Industrial and Applied Mathematics

DEMOGRAPHY

COURSE NO: ST22305DCE **No. of Credits-4**

Course Objectives: The main aim of this course is to describe current population trends, in terms of fertility, mortality and population growth.

Course Outcomes: After successful completion of this course, student will be able to:

- Recognize principle sources of demographic data and evaluate their strengths and weaknesses.
- Deliberate the demographic importance of age structures and the repercussion of variations in age structure.
- Classify the various components of population change, including the effects of changing birth, death and migration rates, and demonstrate their influences on age structure.
- Construct and interpret complete and abridged life tables.

UNIT I

Introduction and definition of vital Statistics, coverage and content errors in demographic data, use of balancing equations, Chandrasekharan-Deming formula to check completeness of registration data. Dependency ratio. Accuracy of age data on sex and age: Whipple's and Myer's indices.

UNIT II

Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on fertility and human reproduction process, Dandekar's modified binomial and Poisson models. Distributions of time to first birth, William Brass Model, Singh's model and Singh's modified model, inter-live birth intervals and of number of births, estimation of parity progression ratios from open birth interval data.

UNIT III

Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life table and its construction: Complete and abridged. Relationship between life table functions and their estimation. Relationship between abridged life table functions. Greville's and Reed-Merrel's methods.

UNIT IV

Migration: concepts and rates. Uses of place of birth and duration of residence data. Population projection: Logistic growth model, fitting of logistic growth model by the method of three points. Frejka's component method. Logistic Model for population growth and their fitting to population data. Use of Leslie matrix.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Bartholomew, D.J. (1982). Stochastic Models for Social Processes, John Wiley.
- Benjamin, B. (1969). Demographic Analysis, George, Allen and Unwin.
- Ching, C. L. (1968). Introduction to Stochastic process in Biostatistics, John Wiley.
- Cox. P. R. (1970). Demography, Cambridge University Press
- Keyfitz, N. (1977). Applied Mathematical Demography, Springer Verlag.

- Spiegelman, M. (1969). Introduction to Demographic Analysis; Harvard University Press.

OPERATIONS RESEACH – II

COURSE NO.: ST22306DCE **No. of credits -2**

Course Objectives: To introduce the advanced concepts of Operations Research

Course outcomes: On successful completion of this course, the students will be able to

- Describe the technique of Integer Programming.
- Understand the concepts of Nonlinear programming.
- Understand the concepts of Quadratic Programming problems.

UNIT I

Integer Programming: Gomory's Cutting Plane algorithm & branch and bounded method for all integer and mixed integer, Dynamic programming: Single additive constraint; additive separable return, single multiple constraints; additive separable returns, Single additive constraints; multiple separable returns.

UNIT II

Nonlinear programming, Formulation, Lagrange multiplier Technique, Kuhn Tucker necessary and sufficient conditions for optimality of an NLPP, constraint multivariable optimization with inequality constraints. Quadratic Programming problems: Wolfe's and Beale's algorithms for solving quadratic programming problems.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Taha H.A. (1982) Operational Research: An introduction;
- Macmillan. Hadley G.(1964) Nonlinear and Dynamic Programming; Addision Wesley.
- Kabmboj ,Puri,N,C;Mathematical Programming
- Bazara and Shetty (1979) Nonlinear Programming Theory And Algorithms; John Wiley
- KantiSwarup, P.K. and Singh,M.M.. (1985) Operation Research; Sultan Chand & Sons.
- Rios's (1989): Optimization Theory and Applications, Wiley Eastern
- Hadley G. and Whitin T.M. (1963) Analysis of Inventory Systems; Prentice Hall.
- Hillier F.S. and Lieberman G.J. (1962) Introduction to Operation Research; Holden Day.Murthy K.G (1976) Linear and Combinatorial Programming; John Wiley.
- Kleinrock L. (1975) Queuing Systems Theory Vol.1, John Wiley.
- Philips D.T., Ravindran A. and Solberg J. Operation Research, Principles and Practice.Saaty T.L.(1961) Elements of Queuing Theory with Applications; McGraw Hill.
- Churchman C.W, Ackoff R.L. and Arnoff E.L. (1957) Introduction to Operations Research.

BIO - STATISTICS

COURSE NO.: ST22307OE **No. of credits-2**

Course Objectives: To introduce the advanced concepts of Bio-Statistics.

Course outcomes: On successful completion of this course, the students will be able to

- Understand the concepts of cohort studies and measures of association.
- Understand the concepts of Diagnostic tests.

UNIT-I

Epidemiological method**:** Evolution of Epidemiology, Causal relationship, establishing a causal relationship, Prevalence, Incidence, Prevalence versus incidence. Types of study design: - Cross-sectional study; Case-Control study measures of association in case control studies, cohort studies; measures of association.

UNIT- II

Importance of sample size in research design**:** Diagnostic tests: - Accuracy of a diagnostic test, sensitivity and specificity; predictive values, limitation of predictive values. Bayes theorem, Likelihood ratio. LR of positive tests (LR+) & LR of a negative test (LR-). Post test odds when the test outcome is positive (negative). Tree method for obtaining post test probabilities, Receiver operating characteristics curve.

RECOMMENDED TEXT BOOKS & REFERENCES:

- Medical statistics, Principles & Methods, K.R. Sundaram, S.N. Dewidi & Sreenivas, BI publications, pvt. Ltd. New Delhi.
- Bio statistics by Daniel.

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COURSE NO: ST22308DCE No. of credits -2

PRACTICAL BASED ON COURSES

ST22301CR & ST22302CR

Using Statistical Software

COURSE NO: ST22309DCE No. of credits -2

PRACTICAL BASED ON

Data Analysis using SPSS

Summary Statistics. Graphical Representation of Data- Bar Charts, Stacked Bar, Histogram, Line diagram, Pie diagram, Box Plot, Exporting Graphs. Basic concepts of Testing (hypothesis, types of errors, power, critical value, level of significance), concept of p-value, one-sample t-test, independent t-test, paired t-test, one way &, two-way ANOVA.
Correlation Analysis: Scatter plot, Karl Pearson's, Spearman's and Partial correlation. Regression Analysis: Introduction to linear models. Simple linear regression involving two variables.
Basic distributions (Binomial, Poisson, Normal, Exponential etc.) Generating random samples from these distributions. Parametric Tests: Normal Probability curve, checking normality assumption using histogram, box plot and quantile (Q-Q) plots. Kolmogorov-Semirnov's and SpiroWilk's tests for normality.

RECOMMENDED BOOKS & REFERENCES

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.
- Ajai Gaur,S. Statistical methods for practice & research: a guide to data analysis using SPSS

DATA ANALYSIS USING STATISTICAL SOFTWARE

COURSE NO: ST22310GE **No. of Credits-2**

Course objectives: To learn basic concepts of Statistical package MINITAB.

Course outcomes: After successful completion of this course, the students will be able to:

- Perform data analysis in Minitab.
- Apply the Minitab for graphics.

UNIT-I

Statistical Software's: MINITAB reading and manipulation of data, descriptive statistics. Commands/ Statements in MINITAB, Working with Software Package MINITAB for graphics (Histogram, Plot, Box plot, Pi-chart, QQ plot, density plot, Stem and Leaf).

UNIT-II

Using MINITAB: Matrix processing (Basic operations, Eigen Values and inversion of Matrices etc.). Correlation and Regression analysis: simple and multiple. Simple hypothesis tests (t, χ^2 and F).

RECOMMENDED TEXT BOOKS & REFERENCES:

- B. Ryan and B.L. Joiner (2001). MINITAB Handbook, Fourth edition, Duxbury.
- R.A. Thisted (1988): Elements of Statistical Computing, chapman and Hall.
- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition.

DISCRETE PROBABILITY DISTRIBUTIONS

COURSE NO: ST22311GE **No. of Credits-2**

Course objectives: To understand the basic elements of probability theory.

Course outcomes: On successful completion of this course, the students will be able to

- Provide a foundation for understandings of probability courses.
- Apply the theory of probability in applications of statistics.

UNIT-I

Discrete Random variable, Distribution function, Probability mass function. Mathematical expectation, Moments, moment generating function and their properties.

UNIT-II

Standard Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, geometric and their mean, variances, moments and moment generating function properties and relations.

RECOMMENDED TEXT BOOKS & REFERENCES:

- S.C. Gupta & V.K Kapoor (2012), Fundamentals of Mathematical Statistics, Sultan Chand & Sons,
- Dudewicz, E.J. and Mishra, S.N. (1988): Modern Mathematical Statistics, Willy, Int'l Students edition

STATISTICAL QUALITY CONTROL

Course No: ST18312OE **No. of Credits-2**

Course objectives: To introduce the elementary concepts of Statistical Quality Control.

Course outcomes: After successful completion of this course, the students will be able to:

- Apply suitable SQC techniques and tools to control processes at various phases of work problems.

UNIT-I

Meaning and scope of SQC, Applications of SQC, Schwartz control chart, Statistical basis of a control chart, control chart for variables ($\bar{X}$, R and S) charts.

UNIT-II

Control charts for attributes (np, p & c) charts. Natural Tolerance and Specification Limits. Operating Characteristic function (OC) and Average Run length (ARL) of $\bar{X}$ chart. Moving average charts**.**

RECOMMENDED TEXT BOOKS & REFERENCES:

- Biswas, S. (1996). Statistical Quality Control, Sampling Inspection and Reliability; New Age International Publishers.
- Montgomery, D.C. (1985) Introduction to Statistical Quality Control; Wiley.
- Phadke, M.S. (1989) Quality Engineering through Robust Design; Prentice Hall.

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